CHICOPEE FALLS

LOCAL PROTECTION PROJECT

SPECIAL STUDY

OF

RAILROAD EMBANKMENT

7

PREPARED FOR

U.S. ARMY ENGINEER DIVISION

NEW ENGLAND

OCTOBER, 1962

By

GREEN ENGINEERING AFFILIATES, INC.

BOSTON MASSACHUSETTS

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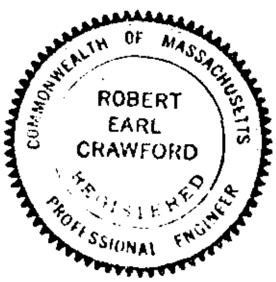


Green Engineering Affiliates, Inc. · ENGINEERS

177 MILK STREET • BOSTON 9, MASS.
Telephone: Liberty 2-5785
(Area Code 617)

October 22, 1962

U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

ATTN: Mr. John Wm. Leslie, Chief,
Engineering Division

SUBJ: Local Protection Project
Chicopee Falls, Mass.

Gentlemen:

We submit herewith our study of the Railroad Embankment on this project, as required in our contract. This constitutes Line Item No. 3.

Very truly yours,
GREEN ENGINEERING AFFILIATES, INC.

R. E. Crawford

Robert E. Crawford
Vice President

REC/dta

Encl.

TABLE OF CONTENTS

PLATES

CHICOPEE FALLS

LOCAL PROTECTION PROJECT

STUDY OF RAILROAD EMBANKMENT

I. INTRODUCTION

A. Purpose - This study was initiated by the Corps of Engineers to provide a condition survey of the railroad embankment immediately downstream of the U. S. Rubber Company plant at the downstream end of the Chicopee Falls Local Protection Project and to develop basic design criteria, methods and costs for stabilizing the embankment and providing adequate slope protection.

B. Scope - This report presents a description of existing conditions both from the viewpoint of slope stability and of streamflow and bank erosion. Conditions are analyzed and solutions are presented, with costs.

II. GENERAL

The Chicopee Falls Local Protection Project is located on the Chicopee River, from the Deady Memorial Bridge in Chicopee Falls to a point on the left bank downstream of the U. S. Rubber Company and on the right to a point approximately 1000 feet further downstream. The location and principal features of the project are shown on Plates No. 1 and 2. The project consists of a line of dike and wall flood protection along the left bank, with widening of the right bank to furnish borrow and allow the stream to be moved to make room for the dikes.

The rail lines serving the factories in the protected area, property of the Boston and Maine Railroad, run on a partially filled shelf along the outside of the bend downstream of the U. S. Rubber Company. There has been a history of erosion and failure along this embankment. On several occasions during floods, the riverside track has been destroyed, apparently through erosive failure. There is a constant problem of settlement and track weaving, as well as continuing erosion. It was considered possible that the changed alignment might aggravate these conditions.

A feature of the proposed work will be flattening the inside of this curve to provide channel widths in excess of 200 feet. The rather considerable benefits to the railroad embankment resulting from this widening are evaluated herein.

III. HYDRAULICS

The present natural channel of the Chicopee River, curving along the railroad embankment in the area downstream from the U. S. Rubber Company buildings, has a normal width in the central portion of the bend of between 130 and 150 feet. During floods, the low area opposite the railroad embankment functions as a natural overbank section over which part of the river flow passes with considerable loss of head, dueto the presence of brush and tree growth and other obstructions. A wedge-shaped high bluff located on the right bank of the entrance to the bend contributes to deflection of the flow towards the main stem and the left bank and probably causes separation of the flow and formation of a wide eddy over the inside of the right overbank section in the bend area. The net result is inefficient use of the right overbank and concentration of the flow in the constricted main stem of the river channel.

Backwater computations for the natural river channel indicate that, during the Project Design Flood, average velocities in the main stem vary up to about 18.5 feet per second. The velocity distribution is expected to vary considerably in the curved area with higher velocities of the order of 50% greater than the average. It is estimated that the high velocity concentration will be generally nearer to the right bank upstream of Section #58 and nearer to the left bank,or railroad embankment, downstream from Section #60. Experience from past floods has shown the left bank to be particularly vulnerable to attack and erosion between Sections #55 and #62. Local interests have undertaken limited protection of this impact area of primary erosion by placement of some riprap. Section locations, stages and velocities are shown on Plates Nos. 2 and 3.

Construction of the proposed flood control project, upstream of Section #52, leaving the bend in its present natural state, would not be expected to have significant effects on the present conditions at the bend. Displacement of a portion of the river by the dike and the compensatory widening of the right bank might be expected to have some effect on the velocity distribution and direction of the beginning of the bend. The velocity in the improved channel would have a better distribution, but would approach the bend at a sharper angle. The net result would be little change in the magnitude of the high velocities accompanied by some shift upstream of the high velocity concentration, still within the area within which existing riprap has been placed.

Extensions of the improvements downstream to include widening of the right bank at the bend as proposed, will have definite beneficial effects upon the hydraulic conditions in the bend area. Backwater computations indicate that average velocities in the main stem will be limited to about 10 fps. In addition, total head losses in the bend area are estimated to be reduced by about 2 feet, which benefits the upstream project, by permitting some reduction in the dike height; the effect being progressively smaller further upstream.

The velocity distribution in the bend will also be altered by the proposed widening. Generally, more uniform velocity distributions will result. High velocity concentrations are expected to occur nearest the right bank upstream of Section #61 and nearer to the left bank downstream of Section #64. Obviously, the proposed widening will cause a significant shift downstream of the impact area, where high velocity concentration will be nearer to the railroad embankment. However, it is expected that due to the overall reduction in the velocities and the smoother curvature, the magnitude of the high velocity concentration will probably be smaller than the velocities expected in the same area under the present natural conditions.

IV. PRESENT CONDITION OF THE RAILROAD EMBANKMENT

A. Surface Conditions - The railroad embankment slope in the vicinity of the sharpest curvature of the river has been the greatest problem area. Loose rock, varying in size up to approximately 30 inches maximum, has been dumped over the slope for a distance of approximately 150 lineal feet along the river in the vicinity of Section A-A, Plate 4. In this zone, the height of slope is approximately 30 feet and the slope is as steep as 1 on 1-1/4. Most of the rock has fallen to the lower half of the slope. There are no trees, and only occasional low bushes growing in this area. Further upstream, there is evidence of dumped rock, mostly at the toe of the slope, with trees and underbrush becoming quite thick. There are several reaches where fairly recent bank erosion has stripped the vegetation and partially undercut the slope, leaving some portions standing steeper than 1 on 1.

The slope on the east side of the railroad rises to a maximum height of approximately 35 feet above the tracks and has a maximum slope of approximately 1 on 1-1/2. The surface is quite densely covered with brush and trees. There are no visual indications of a slope stability problem here.

There are signs of surface erosion of the embankment fill at several points along the bank due to discharge from a single transverse culvert as well as at other points where surface water concentrates and spills over the edge of the slope. This is discussed subsequently in more detail.

B. Subsurface Conditions - Three borings were taken by the Corps of Engineers at the locations shown on Plate 4 during August, 1962. As indicated on the sections through these borings, the depth of miscellaneous fill below the tracks is approximately 10 to 12 feet. Underlying the fill at BH-40 and BH-45 is a 3 to 5 feet layer of medium compact gravelly sandy clay which has been identified as a probable glacial till deposit. Below this material is a layer of soft, somewhat stratified silt and clay, of medium to high pasticity and relatively low shear strength. This layer is 3 to 5 feet thick at BH-40 and BH-45 and is approximately 8 feet thick at BH42. Underlying the soft clay is a zone of loose silts and sands, overlying compact glacial till of undetermined depth.

The miscellaneous fill was found to contain pockets of medium to soft clayey silt as close as 1.5 feet below the track level. The remainder of the fill contains sand, gravel, cinders, coal, and brick fragments, all in a relatively loose condition. While the stable subsurface water level was not determined in borings, it is believed to be responsive to and somewhat above river level.

Several additional borings would be required to verify whether the strata, such as the soft clay layer, are continuous in a direction parallel to the river. For this study, it is assumed that it is. Boring No. 46, some 400 feet upstream of BH-40, also encountered soft clayey materials from depths of 5 to 12 feet.

Laboratory tests on samples of this material from Borings 40 and 42 indicate the liquid limit to be 31 and 35 and the plastic limit to be 27 and 26, respectively. The natural water contents were close to the liquid limits.

V. <u>FACTORS WHICH CONTRIBUTE TO EMBANKMENT SETTLEMENT AND POTENTIAL INSTABILITY</u>

There are at least three factors which contribute to the current settling of the railroad embankment, which are independent of the problems which occur as a result of embankment toe erosion during times of river flooding. It is difficult to assess which of the three is the more important and it is likely that there is an inter-relationship among them.

A. <u>Soft Material In the Track Fill</u> - As noted on the logs of BH-40 and BH-45 there is a layer of soft silty clay at depths of 1.5 to 3.5 feet below the railroad tracks. This material has a low bearing capacity and is considered unacceptable at shallow depths below the ballast. The fact that this material apparently remains in a moist condition due to surface runoff (discussed in "C" below) increases the problem. It is quite probable that the presence of this soft silty clay contributes to settlement and to weaving under rail traffic due to its proximity to the surface.

The actual limits of such material in the fill are not easily detectable. Samples obtained in the fill from BH-42 did not contain soft clay, which may mean that there is not an extensive layer underlying the tracks. A series of shallow borings or hand auger holes would be necessary to check this problem further.

B. <u>Layer of Soft Silty Clay Below Fill</u> - As noted in Plate 4, there is an apparently continuous layer of soft clay, some 4 to 8 feet in thickness, with surface at El. +90 (approximately 15 ft. below the track grade). Reference is made to the stability analyses made on a typical cross-section passing through BH-40 normal to the tracks (Figure 1). Assuming circular failure arcs passing through the fill and along the clay layer, emerging at the face of the slope as shown, we estimated the approximate required shear strength of this clay for the slope to stand with a minimum factor of safety of 1.0. The results of trial circles indicate that the required shear strength in the clay would be about 450 pounds per square foot. This computation is based on conservative assumptions and a "sudden drawdown" condition. Trial No. 1A indicated that the required strength of the clay for the "normal" river condition would be about 80 percent of the above.

Further analyses or refinements in the methods of analysis used are not considered necessary. A more thorough stability study would require several additional borings in the area to define the limits of the clay layer, "undisturbed" samples of the cohesive materials from these borings, and the performance of laboratory shear strength tests on samples recovered.

The fact that there is no evidence of a general slide failure of the type analyzed has proven the stability of the slope. However, from this analysis and from visual examination of disturbed soil samples from borings, it is concluded that the factor of safety is low and that changed conditions, such as an undercutting of the upper slope due to erosion or the addition of more weight at the surface could precipitate a slide failure.

C. Surface Drainage - With reference to Plate 4, a large amount of surface runoff is directed to the sharpest portion of the bend of the railroad embankment. There is evidence that a substantial flow of water passes through a rough channel below the downstream end of the coal pile. A shallow trench extends for a short distance alongside the inner track and terminates near the switch stand. A narrower and shallower ditch continues along the toe of the side slope further downstream but is overgrown with vegetation. It appears that the runoff crosses the tracks in the vicinity of the switch, both through porous portions of the fill and on the surface. There is evidence of surface flow where the fill has been eroded between the ties. Only one culvert was observed; a 12-inch pipe passing below the riverward track approximately 30 feet upstream of the switch. At present, this is not effective since the intake end is almost entirely plugged with fill. The embankment below this drain is badly eroded. There are several other erosion gullies along the slope, particularly at a point about opposite the switch.

This surface water can contribute to an unstable condition in the following ways:

1. This source of water tends to keep the cohesive portions in the fill as well as the underlying natural clay in a moist condition, thus retarding or preventing a buildup of strength with time.
2. The surface runoff obviously contributes to a loss of material adjacent to the tracks and on the slope, even during moderate storms. In addition, losses due to the river erosion during flooding may be increased due to the weakening of the slope by gullies formed by the runoff.

VI. CORRECTIVE MEASURES FOR THE UPPER PORTION OF THE SLOPE

Measures for improvement of the existing conditions are discussed below. It is pointed out, however, that these measures pertain to problems and conditions which are known to exist along the upper portion of the railroad embankment and which contribute essentially to local settlement of the tracks. These problems are considered to be independent of the problem of stream erosion along the lower portion of the slope during flooding and the above measures are considered adequate only on the basis that there is no appreciable loss of slope material due to erosive action by the river. Erosion control is discussed in a subsequent section of this report.

The proposed construction of the dikes and flood wall protection structures upstream of this location would in no way be considered to influence or change the present conditions at the upper slope. Also, as far as erosive action is concerned, the proposed river widening will effectively reduce the peak flow velocities, as discussed elsewhere.

A. Soft Fill Below Tracks

1. General Requirements

a. The extent of the soft compressible material in the fill should be determined by a series of shallow borings or hand auger holes. To properly survey the doubtful area, approximately 20 hand auger holes would be required.

b. Where such materials are found to exist, particularly below the riverward track, they should be excavated and replaced with clean granular fill. Replacement fill materials should be placed in 6 to 12 inch lifts and properly compacted.

2. Approximate Quantity and Cost Estimates

a. Hand auger holes along both tracks - say 20 holes @ 10' depth:

	200 L.F. @ $2.00	$400

(Assuming that the above explorations indicate the need for removing all fill for an average depth of 5 feet, for a distance of 500 feet, starting at a point opposite River Section 58, the following rough quantities and costs are estimated:)

b. Removal and temporary storage of existing trackage and equipment:	1500 L.F. @ $4.00	$6000
c. Excavation and disposal of existing fill (Assume 1/3 of excavated material is re-usable):	6000 c.y. @ $0.75	$4500
d. Purchase and placement of new fill:	4000 c.y. @ $1.75	$7000
e. Placement of salvaged fill:	2000 c.y. @ $0.75	$1500
f. Replacement of tracks and equipment:	1500 L.F. @ $15.00	$22500

Total Estimated Cost...............$41,900

3. In addition to the above construction costs there would of course be many other intangible costs such as delays at the U. S. Rubber Company due to the temporary dis-

rupting of rail service. This would probably be for a duration of 20 to 30 days.

The alternate method of coping with settlements which are being experienced along the line would be to continue to add fill and ballast and to replace or relevel damaged sections of track as settlement occurs. The economics of the decision is beyond the scope of this study.

B. <u>Soft Silty Clay Below Fill</u>

1. Additional borings would be required to better define the limits and extent of this material. The performance of laboratory strength tests on undisturbed samples from the clay would permit a more accurate appraisal of the existing factor of safety against a slide failure.

2. The most effective method of improving the slope stability, while maintaining the present track alignment, would be to change the geometry of the section. A flatter slope and possibly the introduction of a berm in the slope would improve the situation. However, it is felt that if the other recommended corrective measures are taken, the slope will remain stable with respect to a circular slide failure, PROVIDED:

a. No additional weight of fill is placed at the track level.

b. The existing slope is not made steeper or undercut by stream erosion or other means.

C. <u>Surface Drainage</u>

1. <u>General Requirements</u>

a. Intercept the runoff from the slope above the tracks in an improved open ditch along the toe of the slope.

b. At about 4 or 5 locations along the ditch, install inlet structures and transverse drains below the tracks. The discharge end of each drain or culvert would direct the flow to a paved spillway on the outer embankment slope. The drains should be 15 inch diameter reinforced concrete pipes, placed at the time the fill is being replaced.

c. Provide wide, paved spillway areas below each culvert outlet to carry the flow down to the normal river level. These areas should be incorporated into the design of any riprap placed on the slope for stream erosion protection. The paved spillway would require hand-placed stones, keyed into the riprap, for stability.

2. Approximate Quantity and Cost Estimates

a. Excavation of trapezoidal drainage ditch alongside of the inner track:		
	65 c.y. @ $1.50	$ 100
b. Installation of drainage inlet structures:		
	5 @ $270 each	1,350
c. Installation of 15" diam reinforced concrete pipe underdrains. (Assume this work done at time of excavation and replacement of track fill, thus no excavation and fill included here)		
	650 L.F. @ $4.50	2,925
d. Hand-placed stone riprap at exit of pipe underdrains: (separate from riprap required on lower section of slope)		
	6 c.y. @ $10.00	60
Total Estimated Cost		$4,435

VII. MEASURES TO CONTROL STREAM EROSION

The eros regimen at the bend will be considerably altered by the widening under the Local Protection Project. The overall erosion rate in the bend after widening is expected to be comparable to that now experienced on the left bank between Sections 64 and 66. Erosion is experienced in this area, but maintenance has not been sufficiently heavy to cause local interests to riprap this portion of the bank. Similarly, after widening, erosion during normal flow should be minor, and even floods such as 1955 should cause considerably less damage.

For the Project Design Flood of 70,000 c.f.s., velocities are quite high even with widening; uneven distribution would result in local velocities considerably above the average. Stages and velocities are shown on Plate 3. Protection of the embankment from erosion at the Project Design Flood would require fifteen inches of riprap on a minimum bedding of six inches of well-graded gravel. The slope should be filled out to 1 on 1.5, and erosion gulleys and scallops filled before riprapping. This work would also benefit the stability of the slopes as regards circle failures.

Approximate Quantity and Cost Estimates

Site Preparation	1	Job	Lump Sum	$1,000
Bank Gravel	12,000	C.Y.	$ 2.00	24,000
Riprap	7,000	C.Y.	10.00	70,000
TOTAL ESTIMATED COST				$95,000

Maintenance of slopes and replacement of trackage will be reduced after the widening, due to decreased erosion.

Since the present erosion rate is apparently tolerable to local interests, it is unlikely that the above protection will be constructed after erosion is reduced by the widening.

VII. CONCLUSIONS

A. The railroad embankment is currently subject to both stream erosion and surface instability due to poor subgrade. It has a history of washouts and erosive failures.

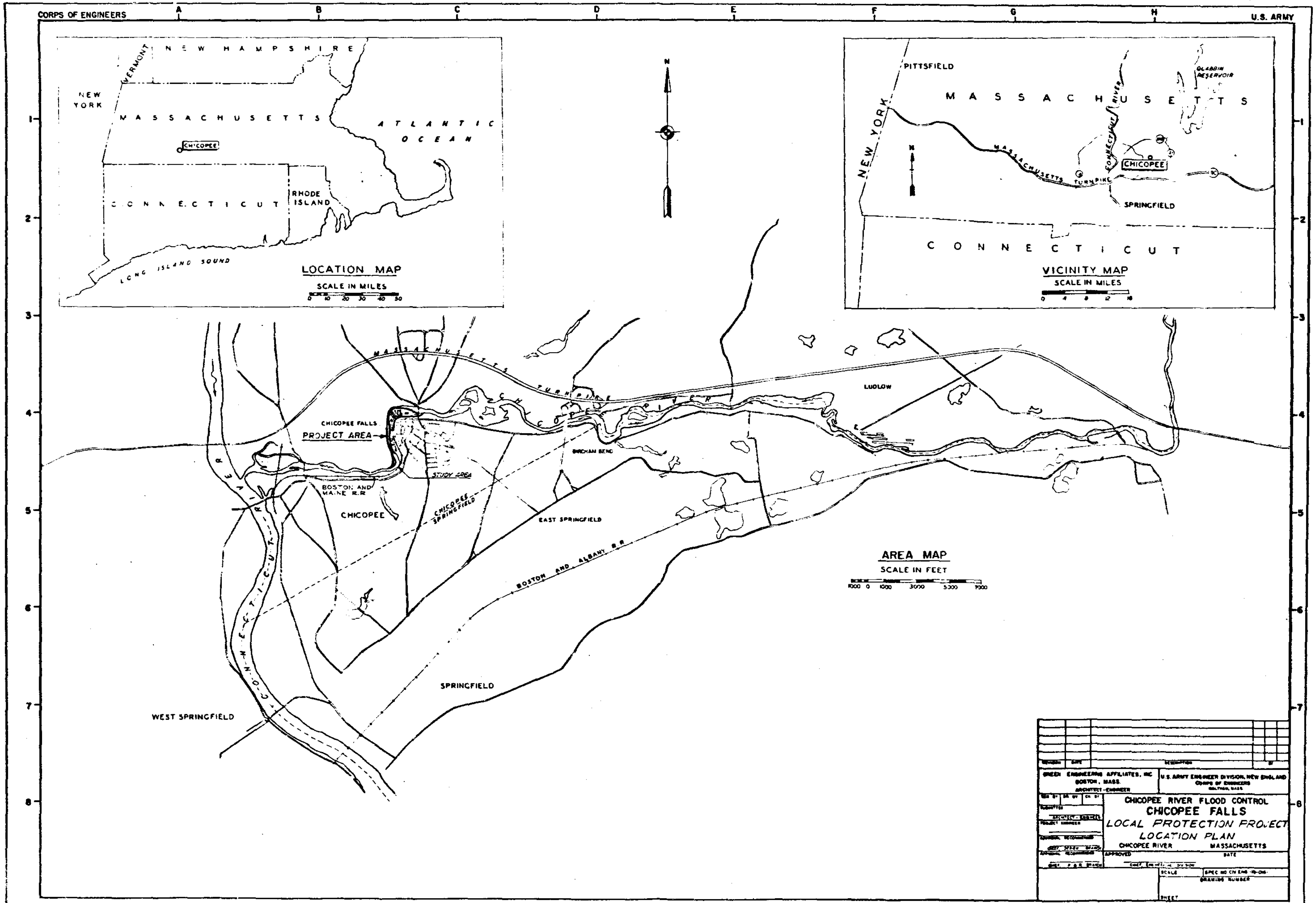
B. The slope problems other than erosion consist of settlement due to soft clays in the fill at shallow depths, of marginal stability due to a natural clay layer approximately 15 feet below track grade, and to the embankment geometry as influenced by erosion, and of poor surface drainage which aggravates the above. None of these will be worsened by the project. Correction of the settlement is estimated to cost approximately $42,000, of the drainage $4500. The stability is considered acceptable with proper maintenance, etc.

C. Stream erosion would be considerably lessened by the project, due to channel widening and reduced velocities around the bend. Slope protection to prevent erosion at Project Design Flood, after improvement, is estimated at $95,000. Protection without the Project improvements was not estimated, but would be more than doubled.

D. The work of this project will have no adverse effects on the railroad embankment, and by reducing erosion will benefit it considerably.

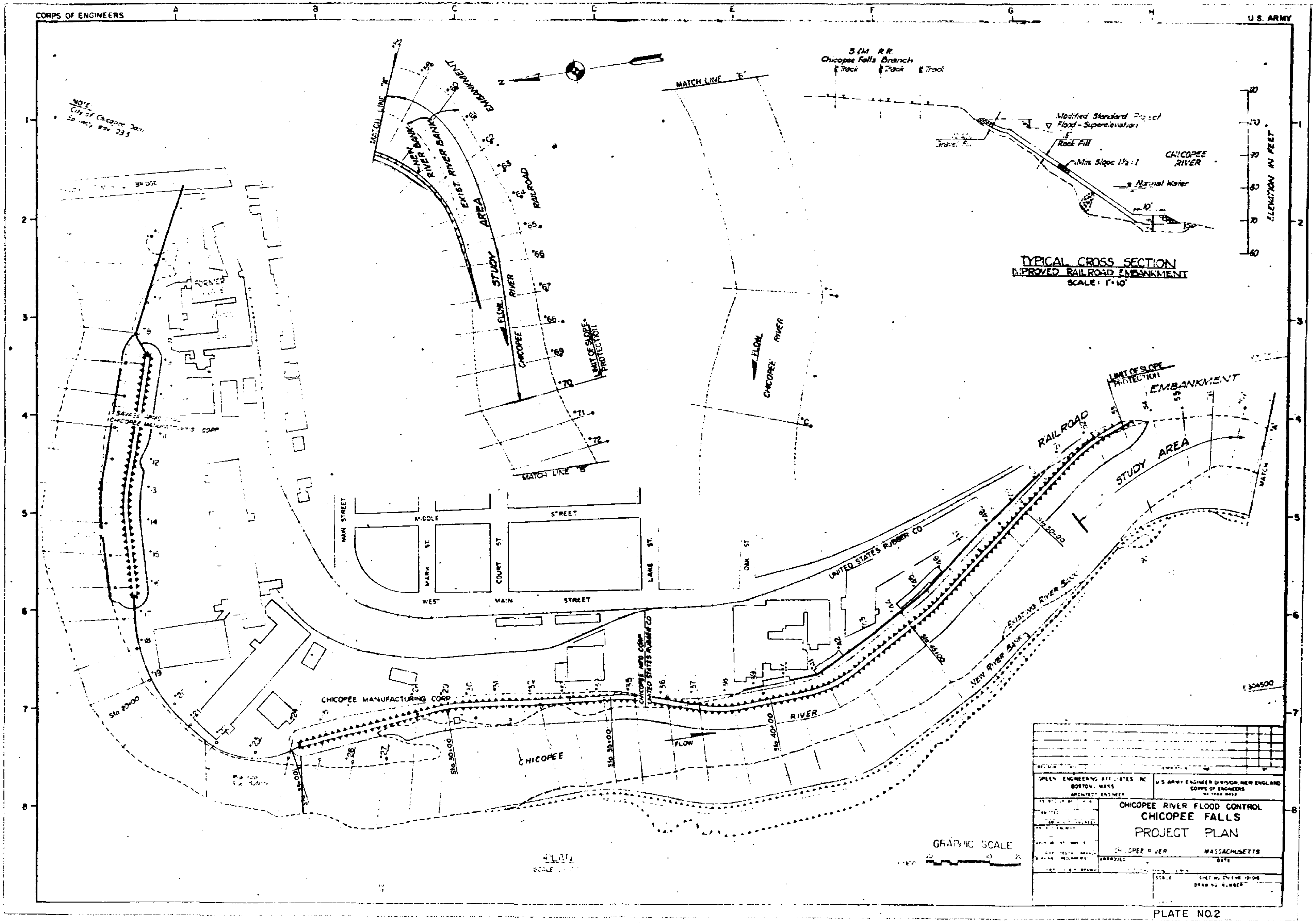
IX. RECOMMENDATIONS

In view of the fact that the work of this Project does not have adverse effects on the railroad embankment, no protective or corrective work on this embankment by the Federal Government is required.



CORPS OF ENGINEERS
U.S. ARMY
NEW HAMPSHIRE
VERMONT
NEW YORK
MASSACHUSETTS
CHICOPEE
ATLANTIC OCEAN
CONNECTICUT
RHODE ISLAND
LONG ISLAND SOUND
LOCATION MAP
SCALE IN MILES
0 10 20 30 40 50
N
PITTSFIELD
QUABBIN RESERVOIR
MASSACHUSETTS
CONNECTICUT RIVER
MASSACHUSETTS TURNPIKE
CHICOPEE
SPRINGFIELD
CONNECTICUT
VICINITY MAP
SCALE IN MILES
0 4 8 12 16
MASSACHUSETTS TURNPIKE
CHICOPEE RIVER
LUDLOW
CHICOPEE FALLS
PROJECT AREA
STUDY AREA
BIRCHAM BEND
BOSTON AND MAINE R.R.
CHICOPEE
CHICOPEE SPRINGFIELD
EAST SPRINGFIELD
BOSTON AND ALBANY R.R.
CONNECTICUT RIVER
AREA MAP
SCALE IN FEET
1000 0 1000 3000 5000 7000
SPRINGFIELD
WEST SPRINGFIELD
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
LOCATION PLAN
CHICOPEE RIVER
MASSACHUSETTS
APPROVED
DATE
SCALE
DRAWING NUMBER
SHEET

PLATE NO 1



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B&M R.R.
Chicopee Falls Branch
Modified Standard Project Flood - Superelevation
Rock Fill
Min. Slope 1½ : 1
CHICOPEE RIVER
Normal Water
ELEVATION IN FEET
TYPICAL CROSS SECTION
IMPROVED RAILROAD EMBANKMENT
SCALE: 1"=10'
MATCH LINE "B"
EMBANKMENT
NEW RIVER BANK
EXIST. RIVER BANK
RAILROAD
STUDY AREA
CHICOPEE RIVER
FLOW
LIMIT OF SLOPE PROTECTION
BRIDGE
MIDDLE STREET
MAIN STREET
MARK ST.
COURT ST.
LAKE ST.
WEST MAIN STREET
UNITED STATES RUBBER CO.
CHICOPEE MANUFACTURING CORP.
CHICOPEE MFG CORP.
UNITED STATES RUBBER CO.
RAILROAD
STUDY AREA
EXISTING RIVER BANK
NEW RIVER BANK
RIVER
CHICOPEE
Sta 20+00
Sta 25+00
Sta 30+00
Sta 35+00
Sta 40+00
Sta 45+00
Sta 50+00
PLAN
GRAPHIC SCALE
GREEN ENGINEERING AFFILIATES, INC.
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U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
PROJECT PLAN
CHICOPEE RIVER
MASSACHUSETTS

PLATE NO.2

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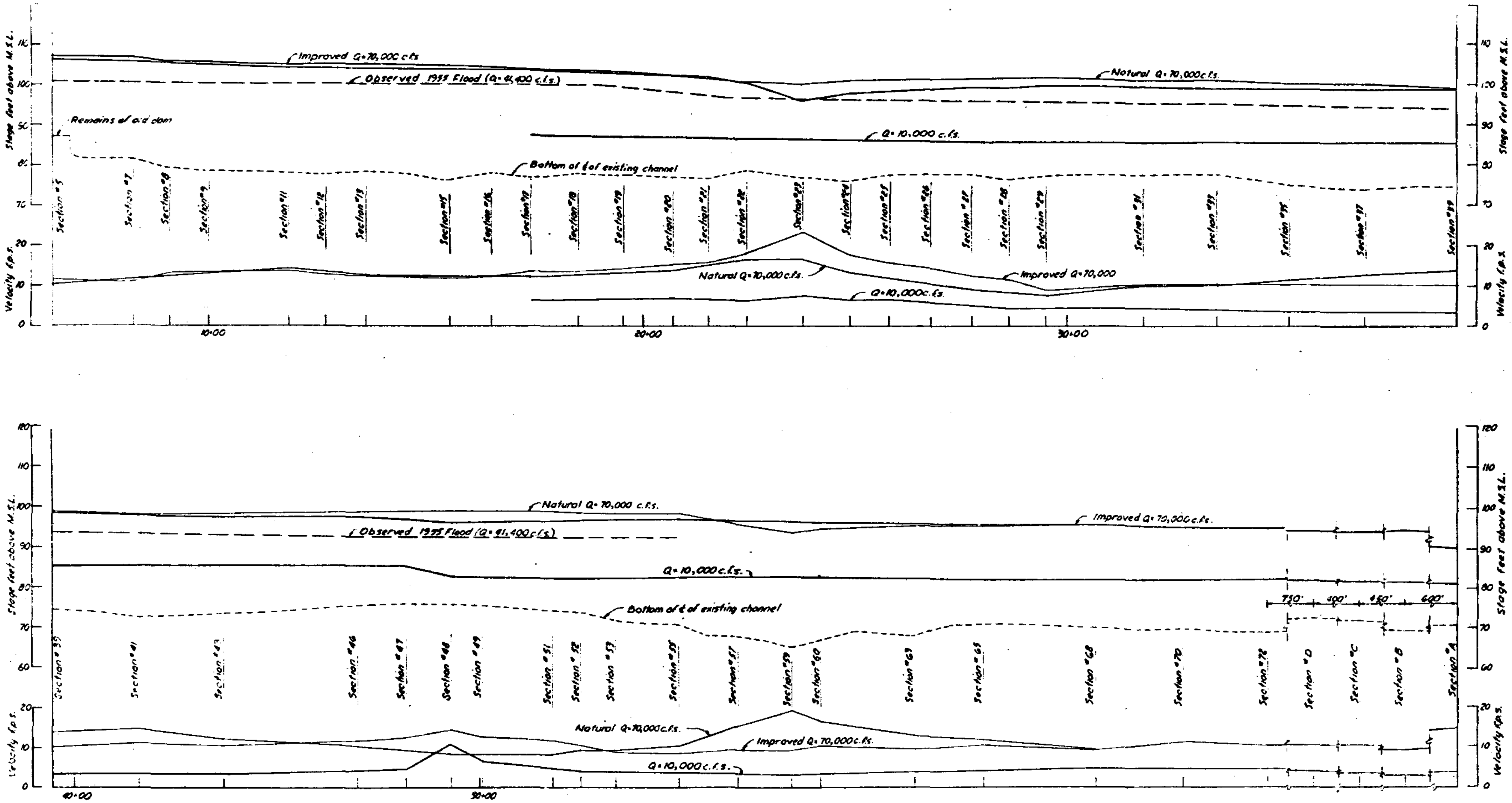

PROFILE

SCALES HOR 1"=100' VERT 1"=10'

GRAPHIC SCALE

1"=100' 100 0 100 200

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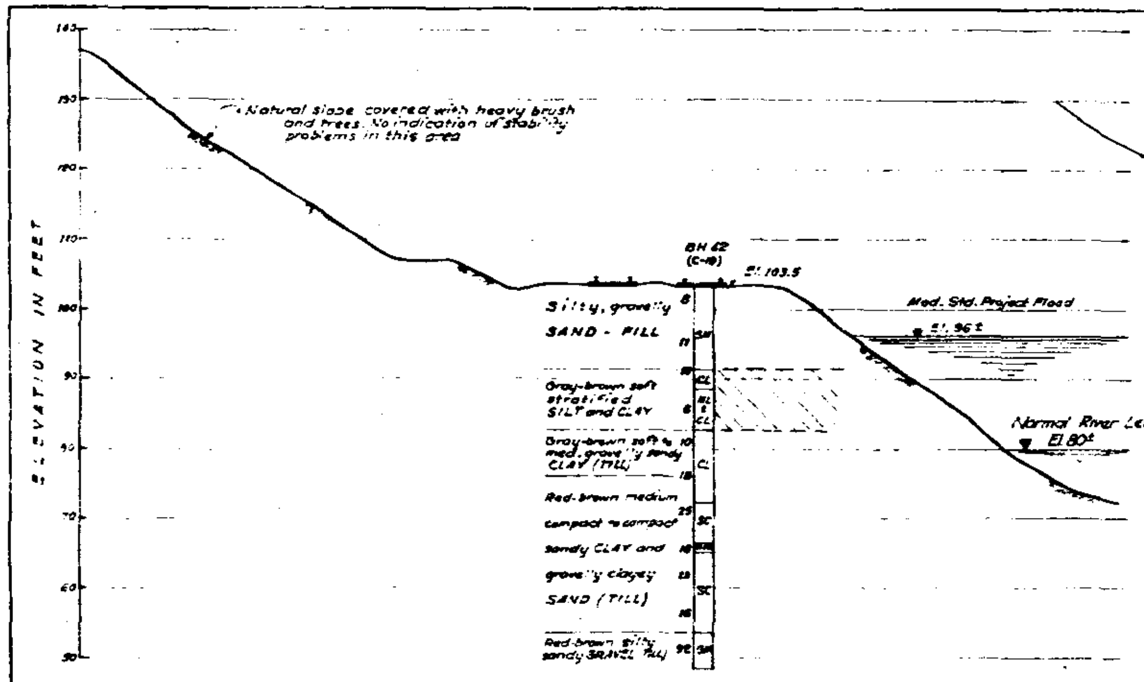
ARCHITECT-ENGINEERS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
WATER SURFACE AND VELOCITY PROFILES
CHICOPEE RIVER MASSACHUSETTS

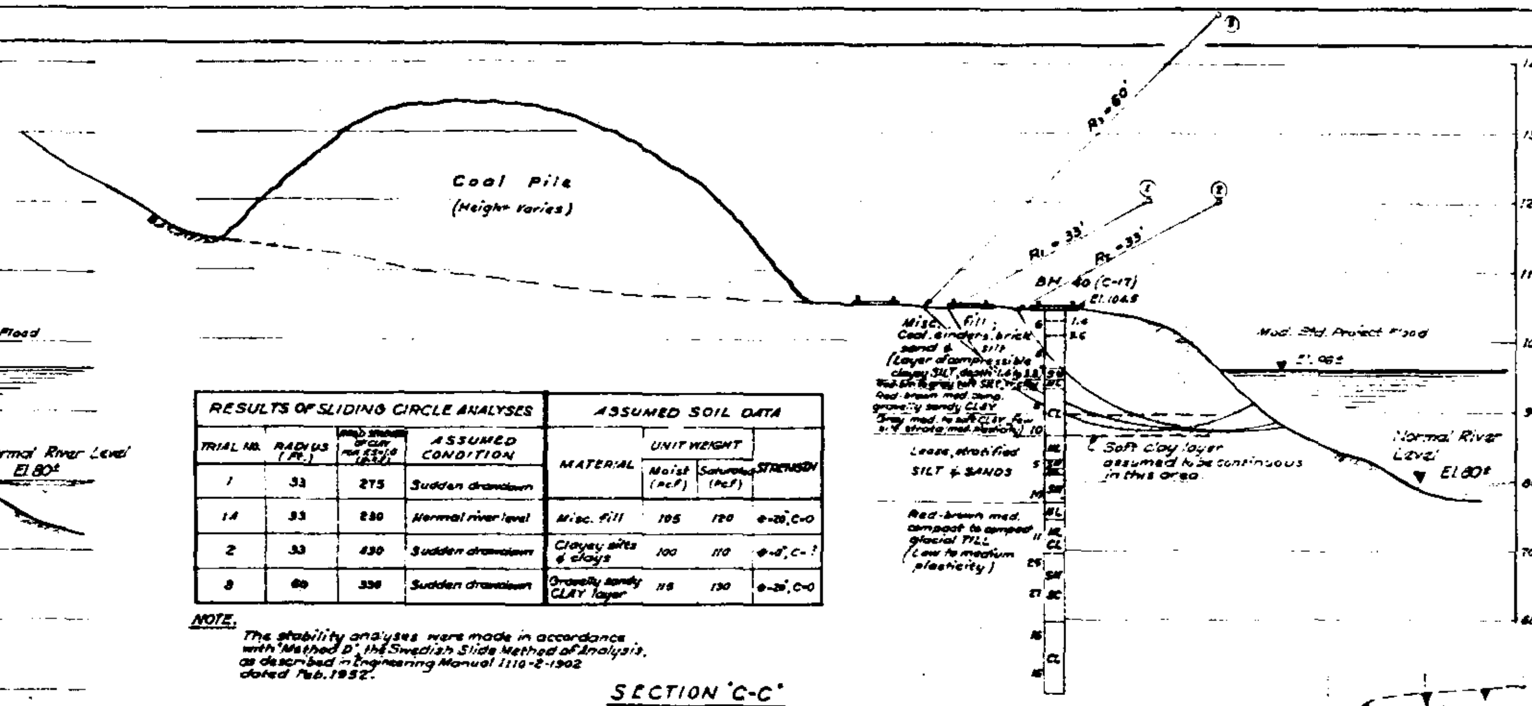
SPEC NO. CIV. ENG.

PLATE NO. 5



SECTION A-A

Scale: 1"=10'



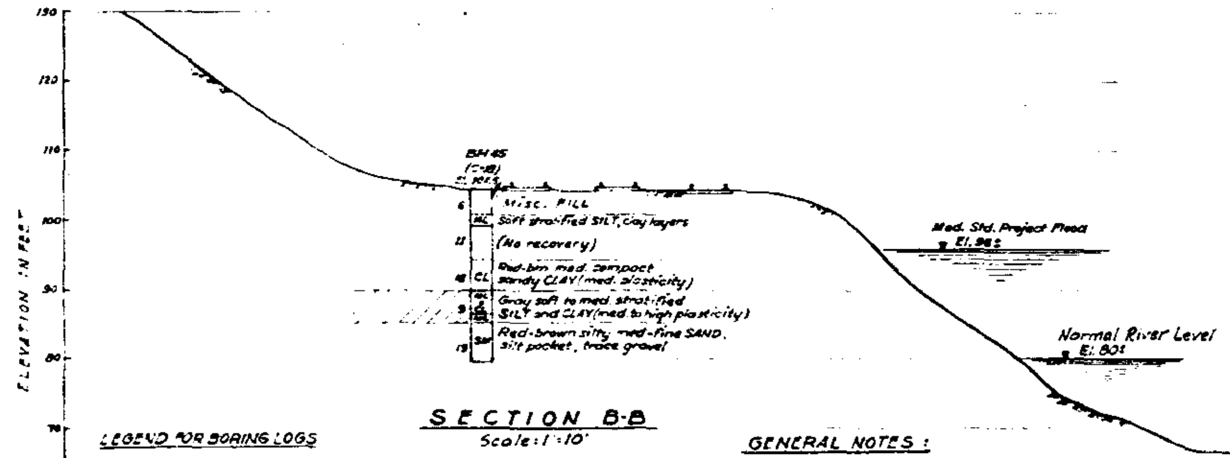
RESULTS OF SLIDING CIRCLE ANALYSES				ASSUMED SOIL DATA			
TRIAL NO.	RADIUS (Ft.)	[illegible]	ASSUMED CONDITION	MATERIAL	UNIT WEIGHT Moist (pcf)	UNIT WEIGHT Saturated (pcf)	STRENGTH
1	33	275	Sudden drawdown				
1A	33	230	Normal river level	Misc. fill	105	120	φ=30°, C=0
2	33	430	Sudden drawdown	Clayey silts & clays	100	110	φ=0°, C=?
3	60	330	Sudden drawdown	Gravelly sandy CLAY layer	118	130	φ=30°, C=0

NOTE.

The stability analyses were made in accordance with "Method D", the Swedish Slide Method of Analysis, as described in Engineering Manual 1110-2-1902 dated Feb. 1952.

SECTION "C-C"

Scale: 1"=10'



SECTION B-B

Scale: 1"=10'

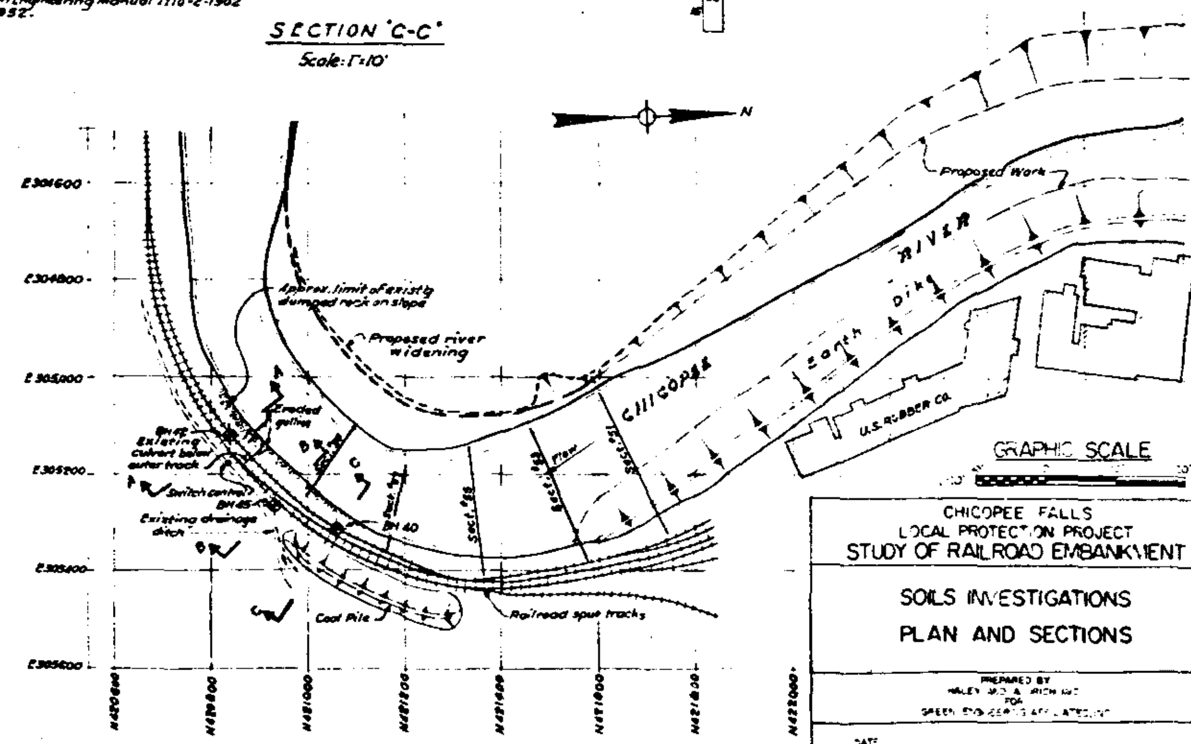
LEGEND FOR BORING LOGS

SM — Group letter symbol according to Unified Soil Classification System

10 — Blows per foot of penetration considered most representative for the depth range, using a 350 lb hammer falling 18" on either a 2½", 2" or 1½" I.D. solid sample spoon, 5 ft. long

GENERAL NOTES:

1. The soil descriptions have been generalized. Refer to the Graphic Logs for more detailed classifications.
2. For purposes of the stability study, it is assumed that the layer of soft SILT and CLAY is continuous below the track area.



LOCATION PLAN

(NO SCALE)

CHICOPEE FALLS

LOCAL PROTECTION PROJECT

STUDY OF RAILROAD EMBANKMENT

SOILS INVESTIGATIONS

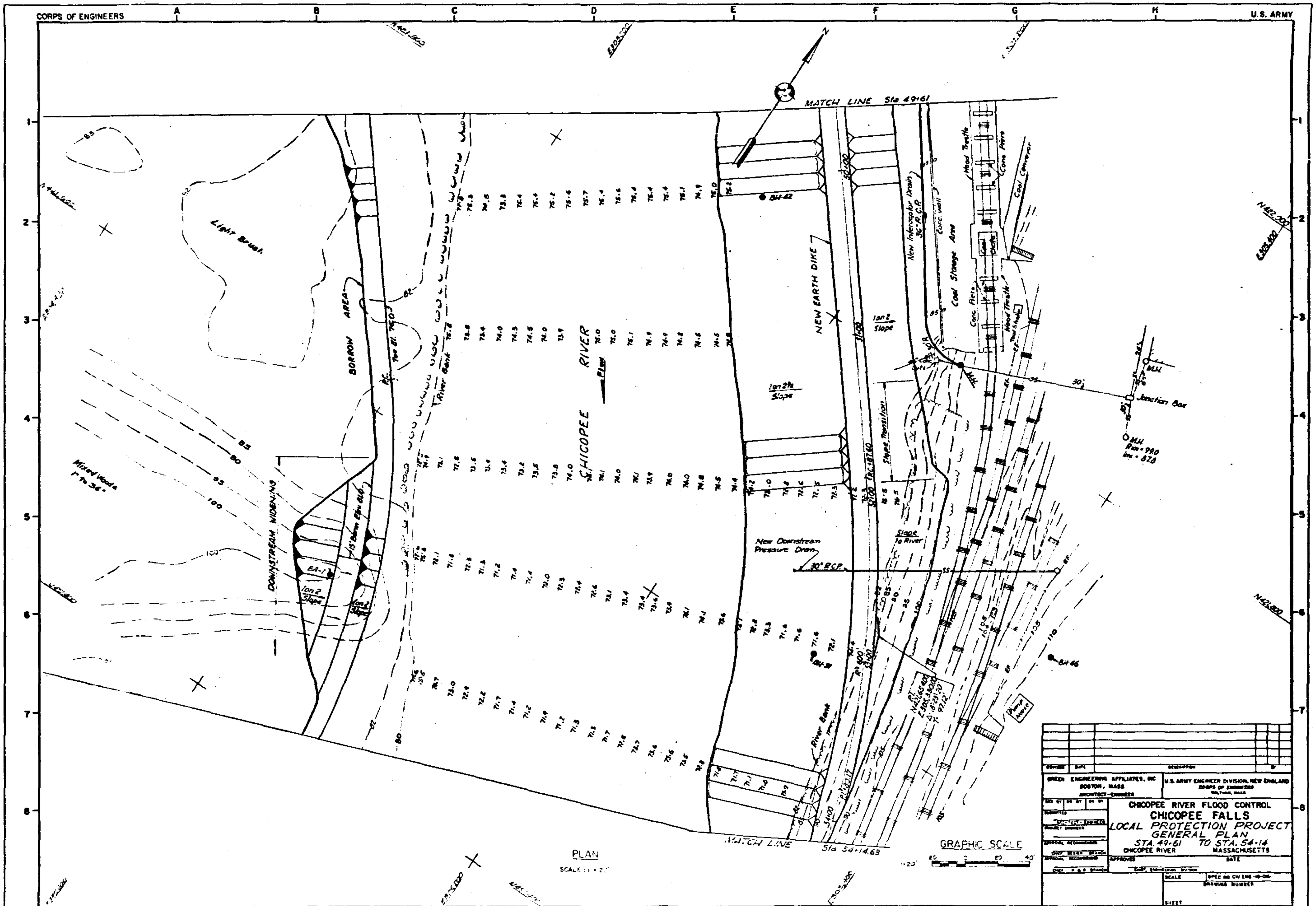
PLAN AND SECTIONS

PREPARED BY HALEY AND ALDRICH INC. FOR [illegible]

DATE

FILE NO. 62-735

PLATE NO 4


CORPS OF ENGINEERS
U.S. ARMY
MATCH LINE Sta. 49+61
Light Brush
BORROW AREA
Mixed Woods
DOWNSTREAM WIDENING
River Bank
CHICOPEE RIVER
Flow
NEW EARTH DIKE
1on2 Slope
1on2½ Slope
New Interceptor Drain 36" R.C.P.
Coal Storage Area
Wood Trestle
Conc. Piers
Coal Conveyor
Junction Box
M.H.
New Downstream Pressure Drain
30" RCP
Slope to River
Slope Transition
Pump House
BH-62
BH-46
BA-1
MATCH LINE Sta. 54+14.63
PLAN
GRAPHIC SCALE
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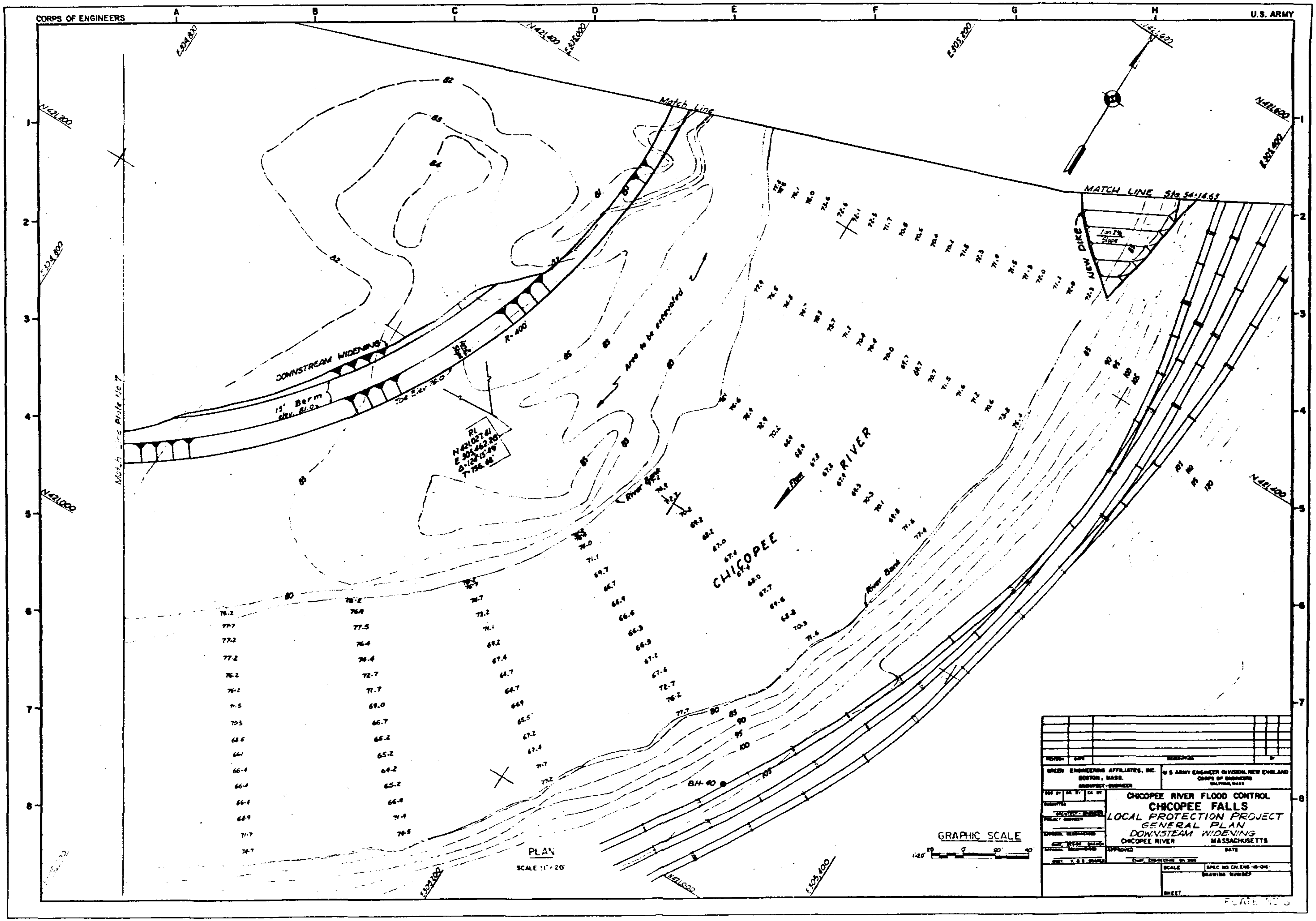
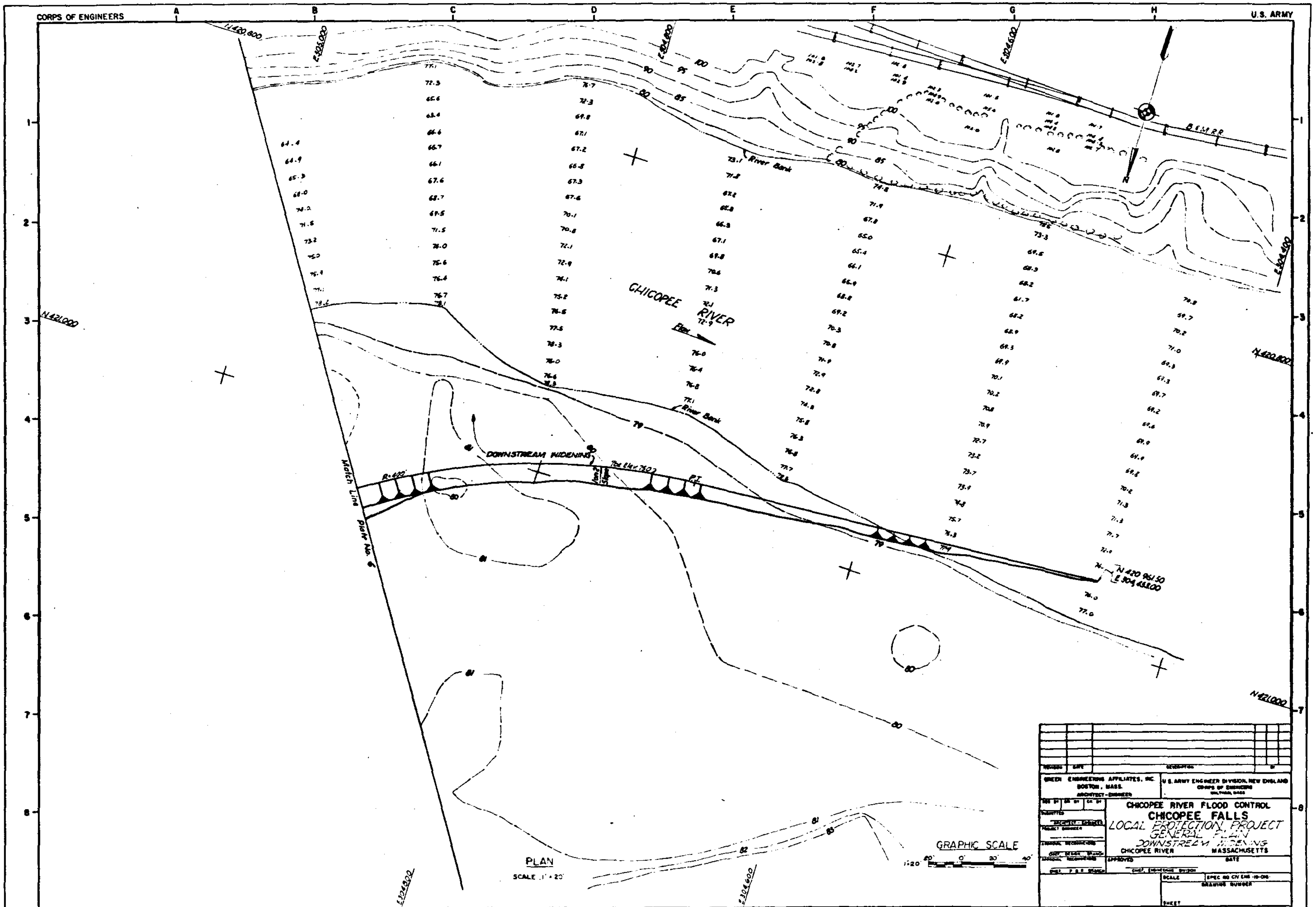
CORPS OF ENGINEERS
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
GENERAL PLAN
STA. 49+61 TO STA. 54+14
CHICOPEE RIVER
MASSACHUSETTS
APPROVED
DATE
SCALE
DRAWING NUMBER
SHEET

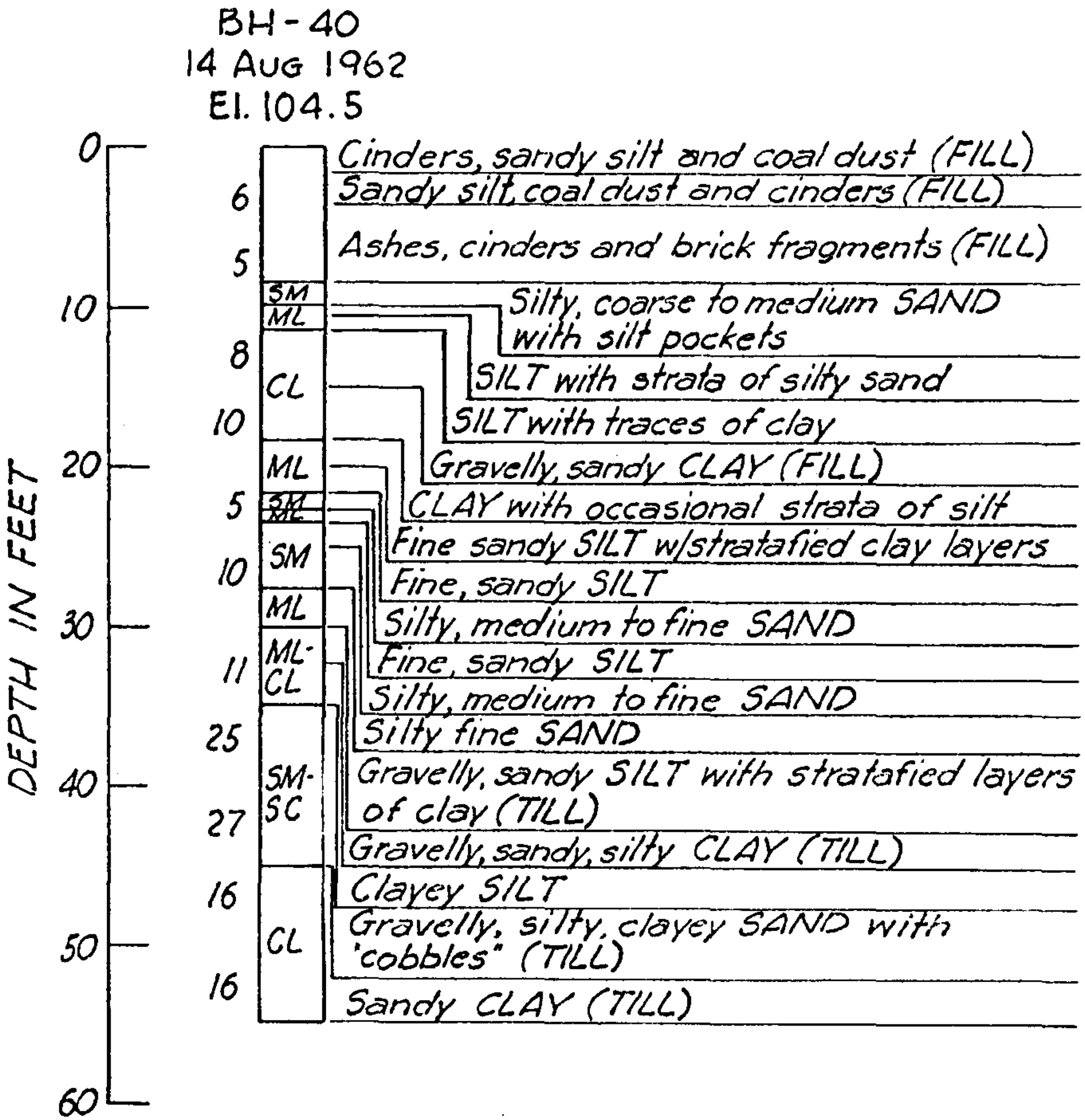
PLATE NO. 5


CORPS OF ENGINEERS
U.S. ARMY
Match Line
MATCH LINE Sta. 54+14.63
NEW DIKE
DOWNSTREAM WIDENING
15' Berm elev. 81.0±
Toe Elev. 76.0
R=400'
Area to be excavated
River Bank
CHICOPEE RIVER
Flow
BH-40
PI
N 421027.41
E 303,462.26
GRAPHIC SCALE
PLAN
SCALE 1" = 20'
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
GENERAL PLAN
DOWNSTEAM WIDENING
CHICOPEE RIVER
MASSACHUSETTS
APPROVED
DATE
SCALE
SHEET
PLATE NO. 5



CORPS OF ENGINEERS
U.S. ARMY
CHICOPEE RIVER
Flow
River Bank
DOWNSTREAM WIDENING
Match Line Plate No. 6
B & M RR
N 420,600
N 421,000
N 420,800
PLAN
SCALE 1" = 20'
GRAPHIC SCALE
GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
GENERAL PLAN
DOWNSTREAM WIDENING
CHICOPEE RIVER
MASSACHUSETTS
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC NO CIV ENG -19-016-
DRAWING NUMBER
SHEET

PLATE NO 7

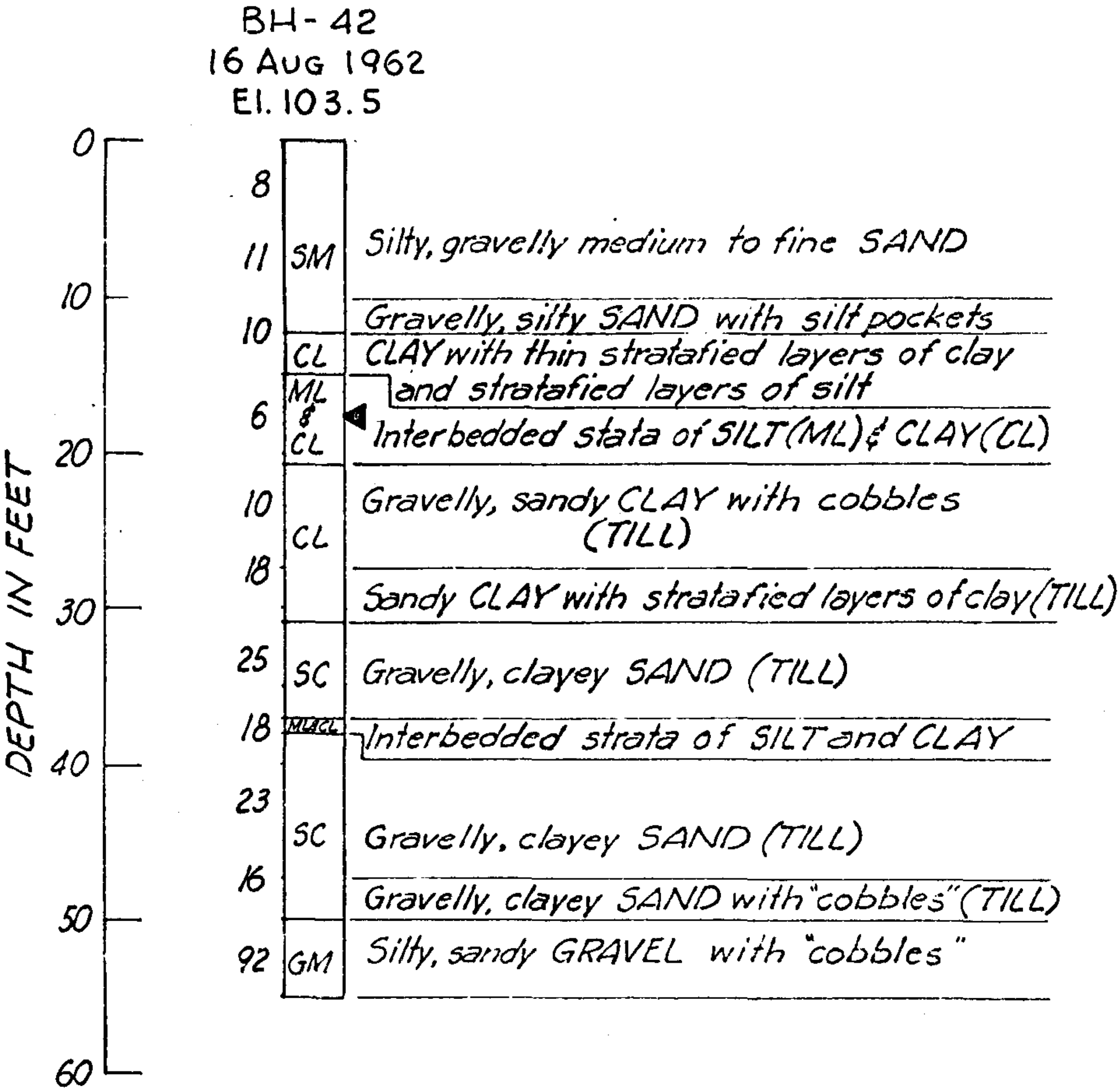


GRAPHIC LOG

LOCAL PROTECTION CHICOPEE FALLS, MASS.

SCALE: 1" = 10'

PLATE NO. 8

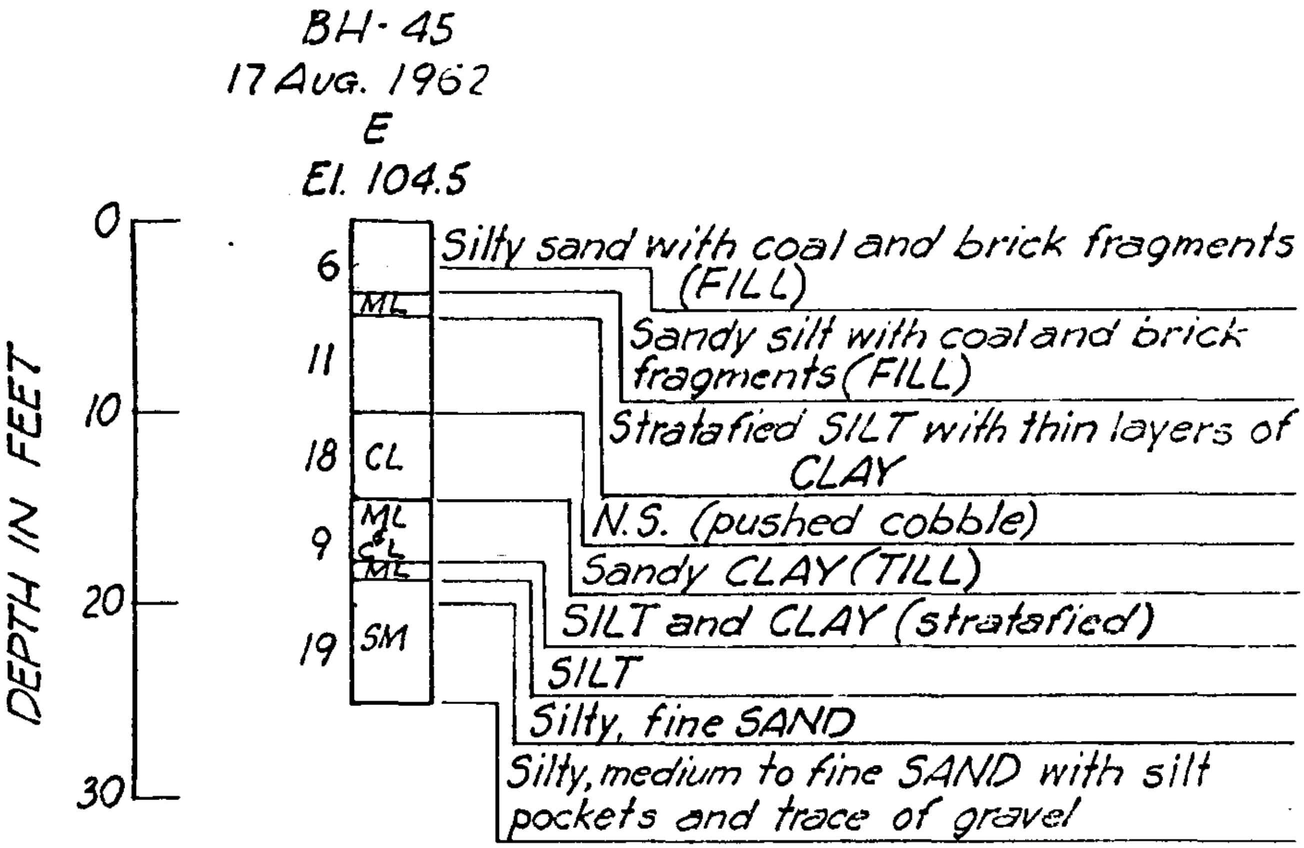


GRAPHIC LOG

LOCAL PROTECTION CHICOPEE FALLS, MASS.

SCALE: 1" = 10'

PLATE NO. 9



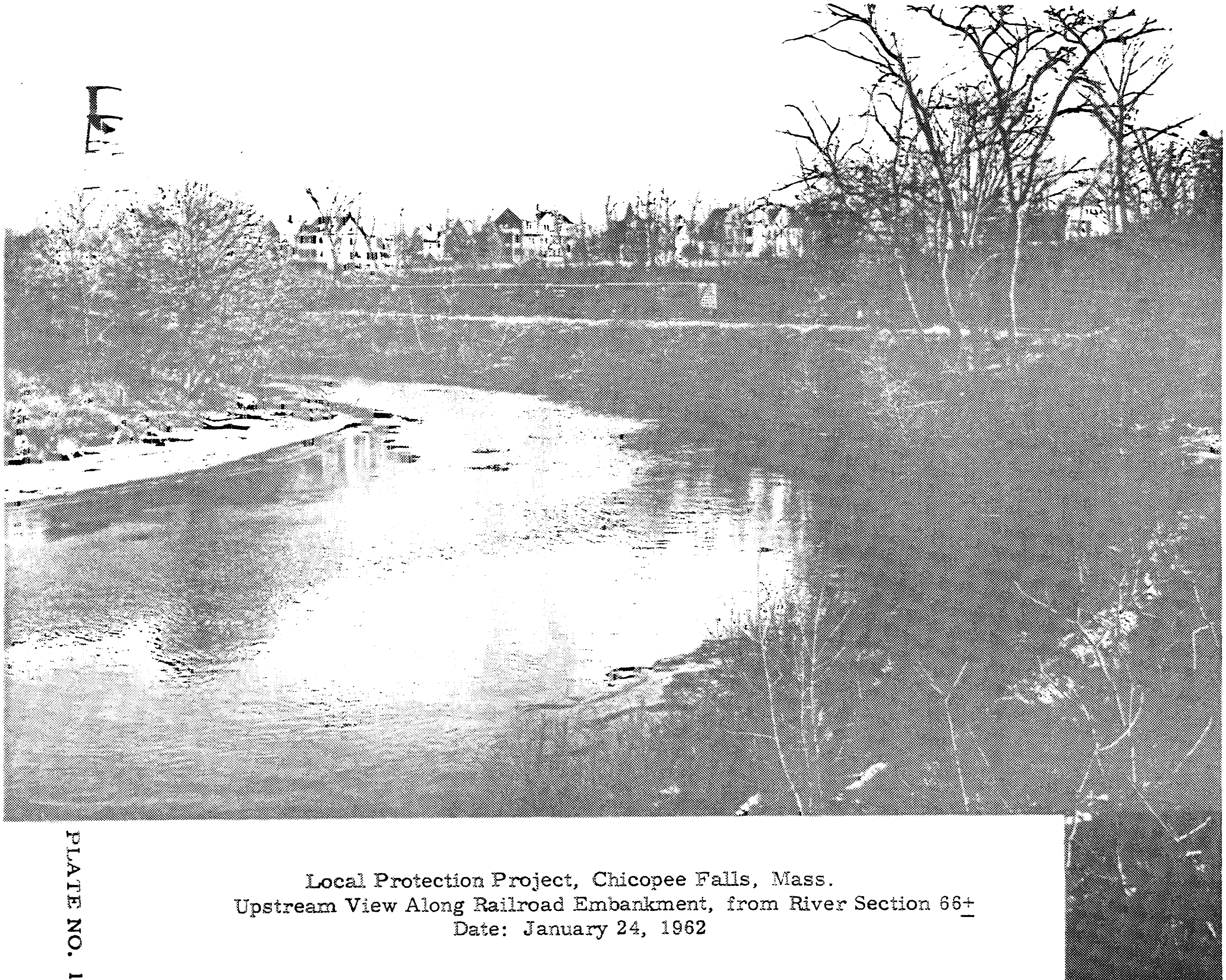
GRAPHIC LOG

LOCAL PROTECTION, CHICOPEE FALLS, MASS.

SCALE: 1" = 10'

PLATE NO. 11

Local Protection Project, Chicopee Falls, Mass.
Condition of Railroad, Looking Upstream from River Section 62±
Date: January 24, 1962



Local Protection Project, Chicopee Falls, Mass.
Upstream View Along Railroad Embankment, from River Section 66±
Date: January 24, 1962

PLATE NO. 12